

## CLAIMS

What is claimed is:

1. A method for detecting defects in a test specimen, the method  
5 comprising:

applying a liquid detection medium to the test specimen;  
exciting the test specimen to cause the liquid detection medium to  
produce a defect signature for a defect in the test specimen; and  
monitoring the liquid detection medium for defect signatures  
10 produced by the liquid detection medium.

2. The method of claim 1, wherein:  
the defect signature comprises a cold signature; and  
the monitoring comprises thermally monitoring the liquid detection  
15 medium to detect cold signatures.

3. The method of claim 2, wherein the excitation of the test specimen  
causes liquid detection medium to be ejected from the test specimen at about the  
defect, the ejected liquid detection medium cooling by evaporation and producing  
20 the cold signature.

4. The method of claim 2, wherein the thermally monitoring comprises  
acquiring infrared images of the liquid detection medium.

25 5. The method of claim 4, wherein the acquiring comprises:  
acquiring an infrared image of the liquid detection medium before  
excitation;  
acquiring one or more infrared images of the liquid detection  
medium during excitation; and  
30 subtracting from the infrared image acquired before excitation the  
one or more infrared images acquired during excitation.

6. The method of claim 1, wherein the defect signature comprises a vibrational mode pattern.

5 7. The method of claim 6, wherein the vibrational mode pattern comprises a standing wave of liquid detection medium on the test specimen generally above the defect.

10 8. The method of claim 6, wherein the vibrational mode pattern comprises an ejection of liquid detection medium from the test specimen at about the defect.

9. The method of claim 1, wherein the monitoring comprises visually monitoring the liquid detection medium to detect the defect signatures.

15 10. The method of claim 9, wherein the visually monitoring comprises acquiring real-time images of the liquid detection medium.

20 11. The method of claim 10, further comprising displaying the real-time images to an inspector.

12. The method of claim 1, wherein the applying comprises misting water on the test specimen.

25 13. The method of claim 1, wherein the exciting comprises ultrasonically exciting the test specimen.

14. The method of claim 1, wherein the test specimen comprises a composite structure.

30 15. The method of claim 1, wherein the liquid couplant includes insoluble particles which form a visible pattern on the test specimen at about a defect after the excitation.

16. A method of detecting defects in a test specimen, the method comprising:

applying a liquid couplant to at least a first surface portion of the test specimen;

5 acoustically exciting the test specimen; and

monitoring the liquid couplant for vibration effects which indicate defects in the test specimen, the vibration effects including at least one of a standing wave of liquid couplant on the first surface portion and an ejection of liquid couplant from the first surface portion.

10

17. The method of claim 16, wherein the monitoring comprises thermally monitoring the liquid couplant for a cold signature.

18. The method of claim 17, wherein the excitation of the test specimen  
15 causes liquid couplant to be ejected from the first surface portion at about a defect, the ejected liquid couplant cooling by evaporation and producing the cold signature.

19. The method of claim 17, wherein the thermally monitoring  
20 comprises acquiring infrared images of the liquid couplant.

20. The method of claim 16, wherein the monitoring comprises visually monitoring the liquid couplant to detect the vibration effects.

21. The method of claim 20, wherein the visually monitoring comprises  
25 acquiring real-time images of the liquid couplant.

22. The method of claim 21, further comprising displaying the real-time images to an inspector.

30

23. The method of claim 16, wherein the applying comprises misting water on the first surface portion.

24. The method of claim 16, wherein the acoustically exciting comprises ultrasonically exciting the test specimen.

25. A method of detecting defects in a test specimen, the method comprising:

applying a liquid couplant to at least a first surface portion of the test specimen;

5           acoustically exciting the test specimen to cause an ejection of liquid from the first surface portion at about a defect in the test specimen, the ejected liquid cooling by evaporation and producing a cold signature for said defect; and

10           thermally monitoring the liquid couplant to detect cold signatures produced by the liquid couplant.

26. The method of claim 25, wherein the thermally monitoring comprising acquiring and analyzing infrared images of the liquid couplant.

15           27. The method of claim 25, wherein the thermally monitoring comprises acquiring real-time infrared images of the liquid couplant and displaying the real-time infrared images to an inspector.

20           28. The method of claim 27, wherein the acquiring comprises:  
          acquiring an infrared image of the liquid couplant before excitation;  
          acquiring one or more infrared images of the liquid couplant during excitation; and  
          subtracting from the infrared image acquired before excitation the one or more infrared images acquired during excitation.

29. A system for detecting defects in a test specimen, the system comprising:

a liquid couplant on the test specimen;

an exciter coupled to the test specimen to excite the test specimen  
5 to cause the liquid couplant to produce a defect signature for a defect in the test specimen; and

a device to detect defect signatures produced by the liquid couplant in response to the excitation.

10 30. The system of claim 29, wherein the device comprises a camera for acquiring images of the defect signatures.

31. The system of claim 30, further comprising a display device for displaying the images to an inspector.

15

32. The system of claim 30, wherein the camera comprises an infrared camera for acquiring infrared images of cold signatures produced by the liquid couplant in response to the acoustic excitation.

20 33. The system of claim 29, wherein the exciter comprises an ultrasonic welder.

34. A system for detecting defects in a test specimen, the system comprising:

5 means for exciting the test specimen to cause liquid couplant on the test specimen to produce a defect signature for a defect in the test specimen; and

means for detecting defect signatures produced by the liquid couplant.

10 35. The system of claim 34, further comprising means for applying liquid couplant to the test specimen.